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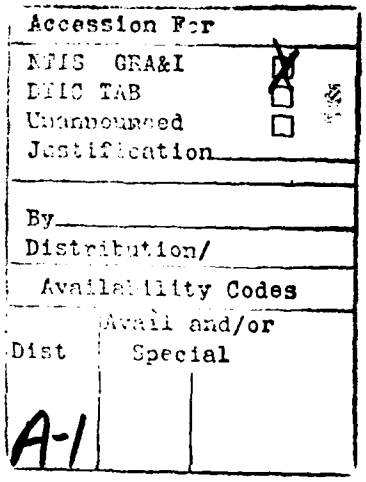

OVERVIEW OF PRODUCTION GAINS FOR MANUFACTURED INTEGRATED CIRCUITS IN CHINA

Jia Zhidong

In recent years, China's integrated circuits productive capacity rose sharply. There have been new series and new product lines; product quality improved steadily while prices declined sharply. Integrated circuits are widely applied in the various sectors of the national economy. However, it is noteworthy that China's expansion of integrated circuit markets has not been adequate, and the numbers of new products have not risen fast enough. So, a very urgent mission in the Seventh Five Year Plan is to spur the integrated circuits markets, and to develop more integrated circuits as demanded by the markets.

To enable the rank and file engineering and technical personnel to more systematically grasp the production gains of integrated circuits manufactured in China by using Chinese-made integrated circuits to speed up the production output of electronic equipment and devices in China, the article gives an overview of production gains of various series integrated circuits built in China.

I. TTL Digital Integrated Circuits

1. CT1000 series: In State Standard CT1000 series, TTL circuits are covered by the product standard of the SN74/54 series made abroad. These two series are interchangeable. At

present, there are a total of 132 kinds of such products made in China, including various gate circuits, triggers, counters, registers, data selectors, and encoders. The principal plants making these products include: State-Operated Dongguang Electric Equipment Plant, 19th Shanghai Radio Plant, Changzhou Semiconductor Plant, State-Operated Shaoguang Electric Equipment Plant, Second Beijing Semiconductor Equipment Plant, and Suzhou Semiconductor Equipment General Plant, among others. Of these plants, some products of the Beijing Dongguang Electric Equipment Plant meet category I technical specifications. There are relatively complete product lines made by the following plants: Beijing Dongguang Electrical Equipment Plant, 19th Shanghai Radio Plant, Changzhou Semiconductor Plant, and State-Operated Shaoguang Electrical Equipment Plant.

2. CT2000 series: The State Standard CT2000 series high speed TTL circuits are interchangeable with the SN74/54H series products that are standard abroad. At present, 25 kinds of these products can be supplied in China. The principal manufacturing plants are as follows: State-Operated Shaoguang Electric Equipment Plant, 19th Shanghai Radio Plant, Seventh Shanghai Radio Plant, Changzhou Semiconductor Plant, Second Beijing Semiconductor Equipment Plant, and State-Operated Shaoguang Electric Equipment Plant. The manufacturing history of this series products is the longest.

3. CT3000 series: The very high speed TTL circuits of the State Standard CT3000 series is interchangeable with the SN74/54S product series standard of Texas Instruments Corporation. The features of the CT3000 series products are high speed (gate delay time, 3 nanoseconds) and power consumption is 19 milliwatts. At present, there are a total of 58 kinds of these products established in production or in trial production. The principal manufacturing plants are as follows: State-Operated Shaoguang Electric Equipment Plant, State-Operated Tianguang Integrated

Circuit Plant, Changzhou Semiconductor Plant, and 19th Shanghai Radio Plant, among other plants.

In terms of the number of product types and productive capacity, the State Operated Shaoguang Electric Equipment Plant and the State Operated Tianguang Integrated Circuit Plant rank first.

4. CT4000 series: The low power consumption Schottky TTL circuits of State Standard CT4000 series are interchangeable with the SN74/54LS series product standard of Texas Instruments Corporation abroad. The CT4000 series circuits embody a good combination of low power consumption and high speed; its speed is 100 percent faster than the standard TTL, and its power consumption is only one-fifth of that for the standard TTL circuits. The typical gate delay time is 9.5 nanoseconds and power consumption is 2 milliwatts. At present, the principal manufacturing plants in China are as follows: State-Operated Tianguang Integrated Circuits Plant, State-Operated Shaoguang Electric Equipment Plant, 19th Shanghai Radio Plant, Changzhou Semiconductor Plant, Second Beijing Semiconductor Equipment Plant, and #8430 Fujian Plant. Since the start-up production in 1981 of this product series by the State-Operated Tianguang Integrated Circuits Plant, 130 types of products are supplied with parts ready for complete assembly. In addition, 54 corresponding series products (State Standard I Category products) occupy the leading technical position in China. At present, there are a total of 158 types of products having established in production or in trial production.

5. Ministry standard T000 series: There are a total of 38 types of the ministry standard intermediate-speed, small-scale circuits, 60 types of the ministry standard intermediate-speed, intermediate-scale circuits, and 23 types of T090 to T117 high-speed, small-scale circuits developed based on China's particular

situation. The principal manufacturing plants are as follows: State-Operated Dongguang Electric Equipment Plant, Changzhou Semiconductor Plant, 19th Shanghai Radio Plant, State-Operated Shaoguang Electric Equipment Plant, Second Beijing Semiconductor Equipment Plant, Seventh Shanghai Radio Plant, and Nanjing Semiconductor Plant, among other plants. Later, this product series will not be considered as a key development and/or manufacturing line. Users are encouraged to adopt the international standard TTL circuits.

In addition to the above-mentioned products series, currently the 19th Shanghai Radio Plant can provide some of ALSTTL and fast TTL circuits.

II. HTL High Antijamming Digital Circuits

At present, there are 29 kinds of HTL circuits made in China, including gate circuits, triggers, counters, encoders, power level converters, and pulse distributors, among others. The main features of this circuit series are high antijamming capability for applications in petroleum and machinebuilding industries, among others. At present, the principal manufacturing plants are as follows: Third Beijing Semiconductor Equipment Plant, Nantong Transistor Plant, and 19th Shanghai Radio Plant; the Third Beijing Plant has the longest manufacturing history, the most numerous product kinds, and the highest sales volume.

This product series is not considered as key products for later development; these products can be replaced by other circuit series. The production volume will be based on user requirements.

III. ECL Ultrahigh Speed Circuits

Common emitter coupling logic (abbreviated as ECL logic) is a nonsaturation type bipolar digital logic.

ECL III series is a very high-speed logic circuit. The series began to be produced in 1968. The triggering frequency of these triggers can be as high as 500 megahertz.

ECL type subnanosecond circuits and high-speed low-power consumption frequency divider circuits are another kind of ECL circuits developed to satisfy requirements of super-high-speed systems.

At present in China, ECL circuits are exclusively produced by the State Operated Tianguang Integrated Circuit Plant. Moreover, this product series is the earliest in China that broke the barriers of -55C and +125C, measuring up to the technical specifications of category I. At present, there are a total of 21 kinds of products covered by the State Standard CE10100 series (same as MC10100 product series standard adopted abroad). There are a total of 13 kinds of products with the ministry standard ECL III series (using the MC1600 series product standard adopted abroad). There are a total of 11 kinds of subnanosecond low-power consumption circuits (using the SP8600 product series standard adopted abroad). Additionally, there are 22 kinds of ECL phase-locked loop and interface.

IV. CMOS Digital Circuits

In the early seventies, for the first time the 4000A series was manufactured by the RCA Corporation in the United States. In mid-seventies, 4000B/14500B series CMOS circuits were jointly developed by the RCA and Motorola Corporation. In 1980, a regular standard for CMOS circuits was formalized in the United States; this is a steady development in the high-speed direction

by 4000B/14500B series CMOS circuits in overcoming the disadvantage of having a lower speed than TTL circuits. In the fall of 1981, MC74HC/54HC and MM74HC/54HC high speed CMOS series were jointly announced by Motorola and National Semiconductor in the United States.

In 1978, China formulated product standards for ministry standard C000 series based on the production level at that time. Since 1982, products standards for national standard CC4000 series have also been formulated on the basis of the CMOS circuit development conditions in China.

In 1978, in China's CMOS CC4000 series, there are a total of 131 kinds of intermediate and small-scale circuits; basically, intermediate and small scale circuits are complete in lines. The selling prices of the CC4000 series basically approached the prices for imported circuits. With further technical innovations, improvements will enhance the productive capacity of plants for developing new products and improving their reliability.

At present, most ministry standard products at the marketplace are the ministry standard 3 to 18 V series, the 7 to 15 V series, and the 8 to 12 V series. In later designing of complete devices, engineers and technicians should be given prime consideration to using CC4000 series products.

At present, the principal CMOS circuit manufacturing plants in China are as follows: 14th Shanghai Radio Plant, Fifth Shanghai Parts Plant, Third Beijing Semiconductor Equipment Plant, Changzhou Semiconductor Plant, Beijing Dongguang Electric Equipment Plant, Suzhou Semiconductor Equipment General Plant, State-Operated Jiangnan Materials Plant, Beijing Qianmen Equipment Plant, and #691 Plant of Aerospace Industry Ministry, among other plants. The 14th Shanghai Radio Plant is a special production enterprise in China for manufacturing CMOS circuits, with the highest productive capacity and the largest sales volume for CMOS circuits; the annual sales volume accounts for 60 percent of the whole nation. In recent years, the 14th Shanghai Radio Plant and the Fifth Shanghai Parts Plant did much work in promotion, application and technical services of CMOS circuits.

The unique features of the CMOS circuits made by the Third Beijing Semiconductor Equipment Plant are quite outstanding. In short, developmental prospects for CMOS digital integrated circuits are quite promising in China.

In the production of CMOS digital circuits, CMOS-LED hybrid circuits are manufactured by enterprises such as the Suzhou Semiconductor Equipment General Plant and the State-Operated Jiangnan Materials Plant based on users' requirements. This kind of circuits has application convenience. It is expected that these circuits will have a sizable market in the integration of machine and electric equipment.

In China, high-speed CMOS circuits have been produced and upgraded also at rapid tempos. In the near future, both the 14th Shanghai Radio Plant and Changzhou Semiconductor Plant will have built production lines for high-speed CMOS circuits with a nearly 10 million pieces annual output capacity. Currently, the 14th Shanghai Radio Plant, the Fifth Shanghai Parts Plant, and Changzhou Semiconductor Plant are providing some products to the market.

V. NMOS Intermediate- and Large-Scale Circuits

This product series is manufactured mainly by the Beijing Dongguang Electric Equipment Plant; there are more than 10 kinds of products, mainly registers, encoders, display elements and counters.

VI. PMOS Digital Circuits

At present, generally there are three product series, as follows: 1. 5G600 series intermediate- and small-scale circuits made by the Fifth Shanghai Parts Plant, Nantong Transistor Plant, and the Fifth Beijing Semiconductor Equipment Plant; 2. B5100

series intermediate- and small-scale circuits made by the Fifth Beijing Semiconductor Equipment Plant; and 3. CP series intermediate- and small-scale circuits made by the 14th Shanghai Radio Plant.

Since the technical development work with PMOS circuits involves the obsolescent kinds and series, these circuits can be replaced by better-performance circuits. Later, production will be in step with users' requirements; the state has not prescribed a unified technical standard.

VII. Operational Amplifier Circuits

Owing to their very extensive application range, the operational amplifier circuits are frequently called universal circuits. At present, there are mainly the following types and series of operational amplifier circuits made in China.

1. There are approximately more than 40 types of state standard operational amplifiers. This series products are in conformity with excellent lines and series of conventional operational amplifiers made abroad that have features of universality, extensive applications and large number of sets in use. The primary conventional operational amplifiers are CF709, CF747, CF748, CF1556, CF4558 and CF301. The high-resistance, high-speed operational amplifiers are CF355 and CF356 made by the State-Operated Yonghong Equipment Plant and the Sixth Beijing Semiconductor Equipment Plant, and CF 715 made by the State Operated Fengguang Electric Equipment Plant and Beijing Dongguang Electric Equipment Plant. High-resistance, wide-band operational amplifiers include the CF351 made by Qingdao Semiconductor Institute and the CF147 made by the State-Operated Yonghong Equipment Plant. The high-impedance operational amplifiers CF3140 are made by the State Operated Fengguang Electric Equipment Plant. The transadmittance CF3080 are made by the

Fifth Shanghai Parts Plant, Beijing Semiconductor Equipment Plant and State-Operated Yonghong Equipment Plant. The high-precision operational amplifiers CF714 and high voltage operational amplifiers CF1436 are made by the State-Operated Fengguang Electric Equipment Plant.

2. Operational amplifiers using conventional product standard adopted abroad: This product series is made by matching to similar products built abroad; pin arrangement and parameter indexes are identical to foreign products. At present, there are a total of 30 lines for this product series, including high-precision operational amplifiers made by the Fifth Shanghai Parts Plant, State-Operated Fengguang Electric Equipment Plant, and State-Operated Yonghong Equipment Plant; ultralow-noise high-precision operational amplifiers F5027 and F5037 made by State Operated Yonghong Equipment Plant; collector open-circuit operational amplifiers F761 made by the Sixth Beijing Semiconductor Equipment Plant; ultralow-drift wide-band high precision operational amplifiers FOP37 made by the Qingdao Semiconductor Institute; and power operational amplifiers FX0021, FX0041 and FX0061 (among other lines) made by the State-Operated Fengguang Electric Equipment Plant.

At present, there are a total of 23 lines of ministry-standard products. The principal manufacturing plants are the Fifth Shanghai Parts Plant, Beijing Semiconductor Equipment Institute, State-Operated Fengguang Electric Equipment Plant, State-Operated Shaoguang Electric Equipment Plant, State-Operated #777 Jinzhou Plant, State-Operated Beijing Dongguang Electric Equipment Plant, Sixth Beijing Semiconductor Equipment Plant, Seventh Shanghai Radio Plant, Qingdao Semiconductor Institute, Jinan Semiconductor Institutre, and Wuxi Semiconductor Equipment General Plant, among others. The principal products are universal operational amplifiers F001 to F008, low-power-consumption operational amplifiers F010 to F013, high-precision

operational amplifiers F031 to F033, high-speed operational amplifiers F050 to F055, and high-resistance operational amplifiers F072 to F075.

3. There are a total of more than 30 lines of factory brand name products for use as standby products with relatively large use volume and long-standing usage. Among the lines, the F005HT and F007HT made by the Qingdao Semiconductor Institute have very good high temperature features; these two lines received high praise from users in the petroleum industry.

4. Hybrid circuits of operational amplifiers: At present, some higher technical requirements or relatively specialized electronic lines are difficult to be made into single-chip integrated circuits; however, integrated modular circuits can well solve this kind of problems, with additional requirements of miniaturization and high precision. So in recent years modular product lines steadily grew in output, and sales volume climbed ever higher. Currently, the State-Operated Yonghong Equipment Plant manufactures more than 50 lines of integrated modular circuits in batch production; the Beijing Semiconductor Equipment Institute manufactured more than 10 lines of modular circuits; and the Seventh Shanghai Radio Plant manufactured eight lines of modular circuits.

5. CMOS analog circuits: This series is one of the lines to receive stressed development in the future. At present, the principal manufacturing plants are the Fifth Shanghai Parts Plant, the 14th Shanghai Radio Plant, and the Third Beijing Semiconductor Equipment Plant, among other plants. The main products are CC14573, CC14574 and CC3130, among other lines.

The State-Operated Yonghong Equipment Plant occupies an advanced technical status in China by introducing the international standards and product lines; the Fifth Shanghai

Parts Plant was the earliest to develop linearity circuits; at present, the plant has the highest productive capacity for operational amplifiers among all plants in China. The State-Operated Fengguang Electric Equipment Plant is a specialized production plant for linearity circuits with very high productive potential and relatively complete product lines. The Beijing Dongguang Electric Equipment Plant is high in technical resources; the plant manufactures products with unique features.

VIII. Nonlinearity Circuits

In recent years, this circuit series grew rapidly in production output. Currently, the principal manufacturing plants are the Fifth Shanghai Parts Plant, 14th Shanghai Radio Plant, State-Operated Fengguang Electric Equipment Plant, Beijing Dongguang Electric Equipment Plant, Third Beijing Semiconductor Equipment Plant, Wuxi Semiconductor Equipment General Plant, State-Operated #777 Jinzhou Plant, State-Operated Yonghong Equipment Plant, and Seventh Shanghai Radio Plant, among others.

The principal products of this series are as follows: 1. A/D, D/A converters, such as CAD14433 and AD7520 made by the Fifth Shanghai Parts Plant, and CAD7106 and CAD 7126 made by the 14th Shanghai Radio Plant; 2. conventional time base circuits CB555 and CB556; 3. phase-locked loop CB565 and CB566, among other varieties; 4. various types of analog switches, logarithmic amplifiers and analog multipliers, such as approach switches SC205 made by the Seventh Shanghai Radio Plant; and function generators 5G8038 and sampling-retention switches 5G582 made by the Fifth Shanghai Parts Plant.

At present, there are more than 60 lines of nonlinear circuits being made or developed in China.

IX. Integrated Voltage-Stabilized (Power) Source

Integrated voltage-stabilized sources represent an important branch of analog circuits; the branch has developed rapidly since the seventies. Since the power source has features of high efficiency and wide adjustable range of output voltage, this type of power sources is extensively applied.

The principal plants making integrated voltage stabilized sources in China are the Fifth Beijing Semiconductor Equipment Plant, Seventh Shanghai Radio Plant, State-Operated Fengguang Electric Equipment Plant, Nantong Transistor Plant, State-Operated Shaoguang Electric Equipment Plant, State-Operated #777 Jinzhou Plant, Fifth Shanghai Parts Plant, 16th Shanghai Semiconductor Equipment Plant, and Beijing Transistor Equipment Institute, among others.

The Fifth Beijing Semiconductor Equipment Plant has the highest productive capacity and the most complete lines of integrated voltage-stabilized power sources. The Beijing Plant made outstanding contributions to the promotion, application and technical services of integrated voltage-stabilized power sources.

Here are most of the product categories for integrated voltage-stabilized power sources made in China: 1. multiterminal integrated voltage-stabilized power sources, such as CW723 made by the State-Operated Fengguang Electric Equipment Plant, Seventh Shanghai Radio Plant, and State Operated #777 Jinzhou Plant; W104 (identical to LM104 made in abroad) made by the State-Operated Fengguang Electric Equipment Plant, and W3085 (identical to CA3085 made in abroad) made by the Beijing Semiconductor Equipment Institute. 2. Three-terminal fixed-type positive and negative integrated voltage-stabilized power sources CW7800 and CW7900 series: the principal manufacturing plants are the Fifth

Beijing Semiconductor Equipment Plant, State-Operated Fengguang Electric Equipment Plant, Seventh Shanghai Radio Plant, and Nantong Transistor Plant, among other plants. 3. Three-terminal adjustable type integrated voltage-stabilized power sources CW117/217/317 and CW137/237/337, among other lines. The principal manufacturing plants are the Fifth Beijing Semiconductor Equipment Plant and Seventh Shanghai Radio Plant. 4. Switch-integrated voltage-stabilized power sources: the principal products are the CW3524 (identical to SG3524) made by the Fifth Beijing Semiconductor Equipment Plant, and CW3420 (identical to MC3420 made in abroad) made by the Seventh Shanghai Radio Plant. 5. Various types of precision voltage standards and current norms: the main products are the W1403 precision voltage standard made by the Fifth Shanghai Parts Plant, and BGW8069 precision voltage standard made by Beijing Semiconductor Equipment Institute.

X. Other Linearity Circuits

This series circuits include all linearity circuits except operational amplifiers, power sources, and special circuits.

The principal products are as follows: 1. intermediate amplifiers, 2. transistor array, such as F3045 (identical to CA3045 made in abroad) made by the Beijing Semiconductor Equipment Institute, and six-diode array SG3039 made by the State-Operated Shaoguang Electric Equipment Plant; 3. Diferential amplifiers such as the FX3049 made by the Tianguang Integrated Circuit Plant; 4. Darlington drive circuits: The Yangzhou Transistor Plant has a relatively long history of making this product series; the State-Operated Fengguang Electric Equipment Plant also began producing FX2001 to FX2005 (identical to ULN2001 to ULN 2005 made abroad) Darlington drive circuits.

XI. Interface Circuits and Voltage Comparators

There are nearly 80 lines of interface circuits made in China, including read amplifiers, two-line drivers, linear receivers, long-line drivers, voltage comparators, high-speed voltage comparators, and low-power-consumption low-mistuning comparators, among others.

The State-Operated Fengguang Electric Equipment Plant, the State-Operated Shaoguang Electric Equipment Plant, and the Beijing Dongguang Electric Equipment Plant manufacture interface and comparator circuits in relatively complete type line; the production history of these plants is fairly long.

XII. Special-Use Integrated Circuits

In recent years, there has been a rapid development of special-use circuits in China. At present, there are the following lines and series of special-use circuits made in China.

1. Television circuits: The Wuxi Microelectronics Joint Operation Corporation has achieved mass industrial production; the corporation makes main-stream circuit products for television receivers used in China with the following products: CD7611, CD7176, CD7609, CD7193, CD7242 and CD7243, among other lines. The Sixth Beijing Semiconductor Equipment and the Jinan Semiconductor Institute have batch production of D5132, D5250, D5435, D5612 and D5622; these varieties have been supplied to users.

2. Audio-frequency circuits mainly indicate integrated circuits used in recorders, and radio receivers. Currently, the lines of frequency- and amplitude-adjustment intermediate-frequency amplifiers include CD7335 (identical to TA7335), CD1018, CD1205 (identical to LA1205), CD7640 (identical to TA7640) D1220 (identical to TA1220); sterophonic decoding circuits CD3361 (identical to LA3361) CD7343 (identical to

TA7343), D7410 (identical to AN7410); single-chip AM/FM circuits D2204 (identical to TDA7204), CD7641 (identical to TA7641);noise-reducing circuits D1011; motor speed-stabilizing circuits D1470 (identical to mu PC1470), D5512 (identical to LA5512); more than 30 lines of power amplifying circuits including CD7240, CD7232, and D4420; and more than 20 varieties of drivers including CD1450 and CD7666.

The principal manufacturing plants of recording circuits are as follows: the Wuxi Microelectronics Joint Operation Corporation, State-Operated Tianguang Integrated Circuits Plant, Tianjin Semiconductor Equipment Plant, 16th Shanghai Semiconductor Equipment Plant, State-Operated Sichuan #879 Qingchuan Plant, Beijing Electron Tube Plant, and 19th Shanghai Radio Plant, among others.

3. Automotive integrated circuits: the State-Operated Shaoguang Electric Equipment Plant is vigorously developing and making automotive integrated circuits.

4. Telecommunication circuits: at present, there are relatively few lines; the principal manufacturing plants are the State Operated Fengguang Electric Equipment Plant and the State Operated Shaoguang Electric Equipment Plant.

5. Other special circuits: The plants making integrated circuits for electronic clocks and watches are the Beijing Dongguang Electric Equipment Plant and the Beijing Qianmen Equipment Plant. The Tianguang Integrated Circuits Plant and others make integrated circuits for cameras.

Additionally, conventional or semiconventional circuits can be made or developed based on special requirements of user units. This line of development is also a key area for future development.

XIII. Large-Scale Circuits

The plants making four-bit microprocessors are the 14th Shanghai Radio Plant and the Beijing Dongguang Electric Equipment Plant, among others. The plants making eight-bit microprocessors are the Fifth Shanghai Parts Plant and the Beijing Dongguang Electric Equipment Plants.

XIV. Specialized Integrated Circuits

The main products are as follows: Hall effect integrated circuits made by the Nanjing Semiconductor Equipment General Plant and the 16th Shanghai Semiconductor Equipment Plant; temperature-sensor integrated circuits made by the 16th Shanghai Semiconductor Equipment Plant; and photoelectric-sensing integrated circuits made by the Suzhou Semiconductor Equipment General Plant.

Specialized integrated circuits are one of lines to be given stressed development in the future.